

U. S. NAVAL SUBMARINE MEDICAL CENTER  
NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY  
GROTON, CONNECTICUT 06340

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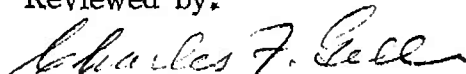
UNDERWATER TEST FACILITIES FOR SENSORY RESEARCH;

A Report of an Exploratory Conference

by

Paul F. Smith

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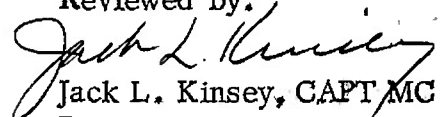


Charles F. Gell, M.D., D.Sc.

Chief Scientist

SubMedResLab

Reviewed by:

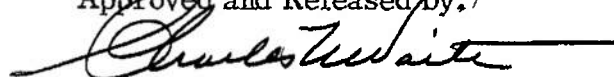


Jack L. Kinsey, CAPT MC USN

Director

SubMedResLab

Approved and Released by:



Charles L. Waite

CAPT MC U.S. NAVY

Commanding Officer

## SUMMARY PAGE

### THE PROBLEM

To ascertain requirements for underwater test environments for sensory research.

### FINDINGS

Minimum requirements for an underwater test tank were defined. A tank, which would be anechoic down to 500 Hz and would have a working space forty feet long, twenty feet wide, and forty feet deep with the appropriate sanitary facilities, would satisfy the needs of many projected research programs of this and other area laboratories.

### APPLICATION

Information developed at this conference will be of use in planning future work in underwater sensory psychology.

UNDERWATER TEST FACILITIES FOR SENSORY RESEARCH:  
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INTRODUCTION

The Submarine Medical Research Laboratory has long been engaged in research into the functioning of man's senses in underwater environments. Such work has been hampered by the lack of adequately controlled test environments. An attempt has been made to forecast future research efforts and to determine what test facilities would best meet the needs of various programs. Being aware that SMRL was not the only laboratory in the area requiring controlled test environments and being sensible of the potential costs of such facilities, it was thought prudent to explore the possibility of joint participation of other laboratories in the planning, construction, and utilization of a central facility. Accordingly, an informal conference on underwater test facilities was held at the Naval Submarine Medical Center in Groton, Connecticut on 13 June 1966. The paragraphs which follow reflect the informal nature of the proceedings.

Attendees:

Naval Submarine Medical Center

Paul F. Smith, Chairman  
J. Donald Harris  
JoAnn S. Kinney  
Grover Smithwick  
Russell Sergeant

Naval Underwater Sound Laboratory

Hugo Wilms

Graduate School of Oceanography, University of Rhode Island

Foster Middleton  
George Offutt  
Jim Fish

Woods Hole Oceanographic Institution

William E. Schevill

Hudson Laboratories Comumbia University

Antares Parvulescu

Mr. Smith welcomed the visitors and introduced the discussion topic with appropriate background information. The Submarine Medical Center is engaged in research on underwater hearing and diver communications. The School of Oceanography at the University of Rhode Island is expanding its research efforts in marine bio-acoustics. Both organizations require adequate acoustical test facilities in order to carry forth planned research.

Dr. Harris outlined some of the research the Auditory Division of the Submarine Medical Center is planning in underwater hearing. In general, research involving the measurement of underwater hearing thresholds, determination of minimum audible angles for underwater swimmers, determining the effects of high intensity waterborne sound on hearing are contemplated. It was felt that for localization work an environment which is anechoic down to 200 cycles per second would be desirable. For threshold work an environment with low ambient background noise and reasonably anechoic throughout the auditory range would be required.

Mr. Fish indicated that his interest is in studying sound production in various soniferous marine organisms. Although some forms, notably crustacea, emit sounds having fundamental frequencies down to 100 cycles per second, most soniferous fish produce sounds having fundamentals between 200 and 500 cycles per second. Mr. Fish pointed out that many animals will not produce sounds in severely restricted tanks. A tank would have to be sufficiently large to allow a partial reconstruction of the organisms natural environment.

Mr. Offutt said that the work he is currently involved in could be carried out in a small tank with sound source located outside of the tank.

Dr. Kinney indicated that much of the work of the Vision Division could be accomplished in an alley about one yard square and 20 feet long. The structure would be such that the spectral density of the medium could be altered by the addition of dyes to the water. For other work, an area 30' x 30' x 10' deep would be required.

Dr. Parvulescu discussed the acoustics of small tanks such as would suit the needs of Mr. Offutt. While it is relatively easy to control pressure variations within such an enclosure, rather unpredictable displacement of the walls of containers occur which give rise to displacements of the water in the tank. Parvulescu suggested that it would be easier to control pressure and displacement activity in a tube within which standing waves could be established. In such a tube, regions of high pressure fluctuation with zero particle displacement and regions of great displacement activity with no pressure variation could be located. The requirements for such tubes at low frequencies are easily met.

The discussion turned to a consideration of the environment which would satisfy all requirements. It was quickly concluded that a tank which would be anechoic down to 200 cycles per second would be too large to be practical.

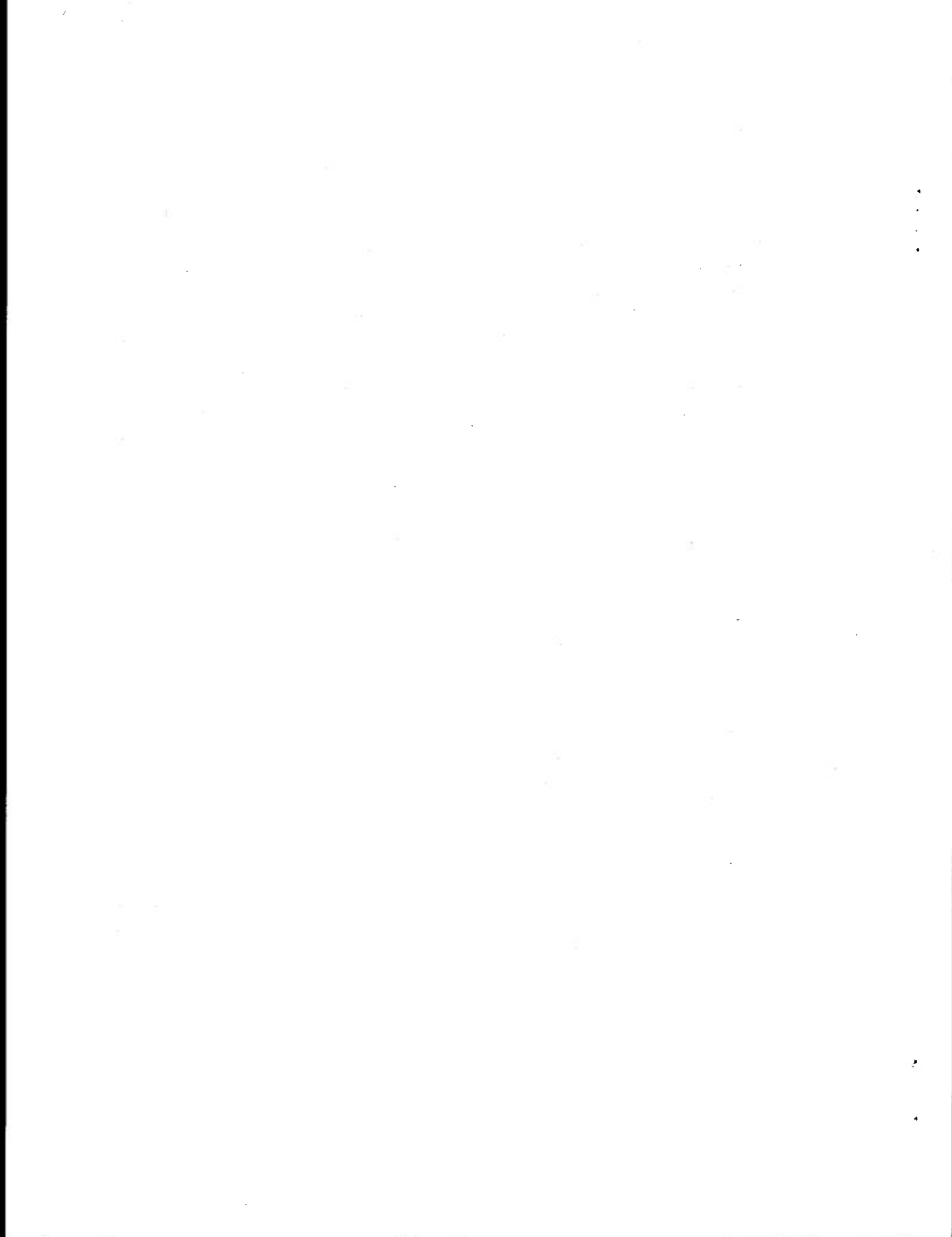
Mr. Wilms then described a tank at USN/USL which is 15' wide, 15' deep and 30' long lined with rubber wedges which protrude into the pool 4 feet all around. The working space in this particular tank then is 7' x 7' x 22'. This tank is fairly anechoic down to 2-3 kilocycles and is usable perhaps down to 1000 cycles. A tank this size would be too small to accomodate the research planned.

Mr. Wilms described a second tank design which called for a width of 40 feet, a depth of 30 feet and a length of 100 feet. This tank would have six foot wedges, hence, a working area of 28' x 18' x 88'. Theoretically this tank should be anechoic down to 500 cycles. The estimated cost of this tank (exclusive of any special heating and filtering equipment which might be required) is two million dollars.

The requirements for anechoic conditions were reconsidered. Mr. Fish agreed that strictly anechoic conditions were not required for his work provided low background levels were obtained and the environment was not highly reverberant. The only work proposed by SubMedCen requiring anechoic conditions down to 200 cycles would be localization of low frequency sounds. Since very low ambient levels would not be required for this work it was agreed to think in terms of conducting that experiment at sea or in a local lake.

From these discussions it was concluded that an anechoic tank similar in design to the 40' x 30' x 100' tank described by Mr. Wilms but being 52 feet square by 32 feet long yielding a working area of 40' x 40' x 20' would satisfy acoustical requirements down to 500 cycles and space requirements for localization and threshold work as well as work such as Mr. Fish is engaged in. In addition, Mr. Schevill said such a tank should be suitable for work with smaller marine mammals up to man-sized cetaceans.

It would appear that the amount of work presently contemplated, and the anticipated activities over the next several years, would insure that such a bio-acoustic test facility would be fully utilized.



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13. ABSTRACT <p>A conference is described which was held at the Submarine Medical Center 13 June 1966, to explore the possibility of joint participation of interested laboratories in the Southeastern Connecticut area requiring controlled underwater test environments in which to investigate the functioning of man's senses. Representatives were present from Navy Underwater Sound Laboratory in New London, Hudson Laboratories (Columbia University), Graduate School of Oceanography at the University of Rhode Island, Woods Hole Oceanographic Institution and the Submarine Medical Center.</p> <p>Since it was estimated that the ideal tank to satisfy all requirements would cost at least two million dollars, a less expensive bio-acoustic test facility was described which would meet most of the needs of the group: an anechoic chamber 40' x 30' x 100', satisfying acoustical requirements down to 500 cycles and space requirements for localization and threshold work. Some other types of investigations would have to be conducted at sea or in a local lake.</p>			

#### KEY WORDS

**LINK A**

LINK B

LINK C

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2.	Vice Chairman
3.	Secretary
4.	Treasurer
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